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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/434,736 11/02/99 KIM

S 000939-07360

020350 MMC2/1109  
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EXAMINER

PERT, E

ART UNIT

PAPER NUMBER

2813

DATE MAILED:

11/09/00

**Please find below and/or attached an Office communication concerning this application or proceeding.**

**Commissioner of Patents and Trademarks**

**Office Action Summary**

Application No.

09/434,736

Applicant(s)

KIM ET AL.

Examiner

Evan T. Pert

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

**Status**

- 1) ☒ Responsive to communication(s) filed on 08 September 2000.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-88 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-88 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claims \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. § 119**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☐ All b) ☐ Some \* c) ☐ None of the CERTIFIED copies of the priority documents have been:
1. ☐ received.
2. ☐ received in Application No. (Series Code / Serial Number) \_\_\_\_\_.
3. ☐ received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. & 119(e).

**Attachment(s)**

- 15) ☒ Notice of References Cited (PTO-892)                      18) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)                      19) ☐ Notice of Informal Patent Application (PTO-152)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_                      20) ☐ Other: \_\_\_\_\_

**DETAILED ACTION**

***Claim Objections***

1. Claims 12, 17, 32, and 41 are objected to because the record is clear that the first contact hole is of substantially equal depth to all the other holes in the first layer, but claims 12, 17, 32, and 41 do not make this clear. Support of the examiner's position is found on page 27 of applicant's response filed 9-8-00, comprising the paragraph starting with "Second.".

Appropriate correction is required.

***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-88 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gutierrez in view of Hashimoto et al..

Both Gutierrez and Hashimoto et al. teach methods in forming multilevel interconnects. The examiner takes Official Notice that it was well known at the time of applicant's invention that a first set of nodes in a multi-level interconnect could include a junction layer, oxide layer, a gate electrode, and other patterned conductive layers. It was also well known that a second level could include patterned conductive layers isolated by being spaced apart.

Gutierrez teaches a junction layer (116), oxide layer (122), gate electrode (118), patterned conductive layers on the oxide (114), and patterned conductive layers on the first insulating layer (220). The fact that Gutierrez does not teach "exposing the gate electrode" when opening holes in the first layer does not mean "opening a hole over the gate electrode" constitutes an inventive step. It was well known to those of ordinary skill in the art that a gate electrode would need to connect through a layer, and an opening "over the gate electrode" would thus be needed before filling the via.

Gutierrez recognizes that any nodes can be interconnected with his method. Gutierrez teaches that the first and second insulating layers are of essentially uniform thickness. This causes holes in the first layer "to be of substantially equal depth" and holes in the second layer "to be of substantially equal depth." Thus Gutierrez teaches a "two-step" deposition of conductive material, like applicant, where the "second step" forms, for example, plug 220. Gutierrez names his resultant conformal layers "conductor-insulator layers" [abstract].

While Gutierrez requires "a seed" for selective deposition, he also teaches that the substrate can act as a seed such that no seeding step is required [col. 5, lines 11-24]. In fact Gutierrez recognizes Tungsten on silicon as useful for selective deposition by CVD [col. 2, lines 63-66 and col. 5, lines 46-52].

Applicant does not teach what methods applicant employs to "not require a seed", but simply relies on the presence of the phrase "selective tungsten thin films 9 by the CVD method" in the specification to enable CVD with "no seeding". Gutierrez

actually explains the entire deposition step that does not require a seed, involving selectively depositing tungsten in a hole with a silicon bottom.

Gutierrez does not teach the advantage of flaring the upper part of the openings in an insulating layer, but Hashimoto et al. do teach creating this shape in a plurality of contact holes in an insulating layer (Ref 44 in Fig. 8A).

It would have been obvious at the time of the claimed invention to have combined the teachings of Gutierrez with Hashimoto et al. to arrive at the claimed invention. One of ordinary skill in the art would have been motivated to use tapered openings to get better step coverage with tighter packing at the bottom of the opening.

Regarding the unique limitation of "by one single step" in claim 5, this has been interpreted simply as meaning that a seeding material need not be deposited, which is clearly anticipated by Guterriez.

Regarding the unique limitation of "in a continuous step" in claim 10, Gutierrez teaches a "continuous step" wherein the gas flow is changed during the step.

Regarding the limitation that the 1<sup>st</sup> conductive layer is grown over and "extends slightly beyond" the contact holes in the first insulating layer, Hashimoto et al. teach that CVD tungsten could be grown above the holes, and then etched back leaving a landing pad for the next conductive deposit [col. 6, lines 42-45].

Regarding limitation numbers 43 to 57 of the matrix as applied to dependent claims 18, 22, 24, 25, 33, 35, 37, 38, 42, 44-46, 48-54, 58-62, 69-71, 73-79, 83-87, the examiner takes Official Notice that these limitations set forth nothing novel. These limitations were well known teachings within the knowledge of one of ordinary skill in the

art who would have been readily appraised of such upon gaining the teachings of Gutierrez and Hashimoto et al..

***Response to Amendment***

3. The examiner has presented a matrix of claim limitations in the last Office Action (Paper No. 6). This matrix is presented again, in updated form, based on applicant's amendment.

"X" indicates each newly added limitation. Brackets indicate deletions. For example, "71" is now in brackets since this claim was cancelled.

Furthermore, X\* as applied to limitation number 19, indicates that --x-- should have been marked in the first Office Action, but was omitted due to typographical error.

4. The examiner acknowledges applicant's intent to re-submit a formal establishment of ownership [bottom of page 23 of response filed 9-8-00]. However, as of this writing, the re-submitted paper was not matched to the file.

***Response to Arguments***

5. Applicant's arguments with respect to claims 5-88 have been considered but are moot in view of the new ground(s) of rejection.

6. In view of the newly discovered Hashimoto et al. reference, all previously indicated allowable subject matter is rescinded.

7. Objection to claim 3 withdrawn in view of amendment.

8. In view of applicant's arguments presented on pages 24-25 of the response filed 9-8-00, 112 paragraph 1 rejections are withdrawn.

9. In view of applicant's arguments presented on pages 25-26 of the response filed 9-8-00, 112 paragraph 2 rejections are withdrawn.

10. In view of applicant's arguments presented on page 27 of the response filed 9-8-00, rejections based on recapture are withdrawn, noting that claim objections under item 1 of this Office Action must be addressed.

### ***Conclusion***

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Takahumi et al. are cited for teaching a stepped via wherein "the upper portion is wider than the lower portion".

Flanner is cited for teaching a method of filling via of differing depths with selective CVD.

Flatley et al. is cited for teaching motivation to flare the upper part of a via opening [col. 1, lines 10-23].

MacRae et al. is cited for teaching motivation to flare the upper part of a via opening [col. 1, lines 15-18].

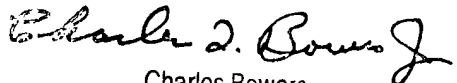
The entire Chapter 4 of Wolf is cited for an overview of the state of the art in multilevel-interconnect technology, well before applicant's claimed invention. Issues such as planarization and selective via filling are discussed at length.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Evan T. Pert whose telephone number is 703-306-5689. The examiner can normally be reached on M-F (7:00-3:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers can be reached on 703-308-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

ETP  
November 6, 2000

  
Charles Bowers  
Supervisor Patent Examiner  
Technology Center 2300



MATRIX OF LIMITATIONS vs. CLAIMS

CLAIM LIMITATIONS		1	5	6	10	12	15	17	20	23	27	30	31	32	34	36	39	41	66
		Independent Claim Number																	
A	1. Preamble: Method to fill contact holes with metal by 2-step metal deposition process	x	x																
A	2. Preamble: Method of forming a substrate with contact holes			x	x														
A	3. Preamble: Method of forming a substrate with contact holes filled by multi-step deposition of conductive layers					x													
A	4. Preamble: Method of forming a semiconductor with contact holes filled by multi-step deposition of conductive layers						x	x	x	x	x							x	
A	5. Preamble: Method of forming a semiconductor with contact holes filled by multi-step deposition of metal layers											x	x	x	x	x	x		
A	6. provide substrate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
A	7. substrate is silicon	x	x				<u>X</u>												
A	8. form oxide (e.g. field oxide)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
A	9. form junction layer or "1 <sup>st</sup> and 2 <sup>nd</sup> regions"	x	x	x	x	x			x	x	x	x			x	x	x	<u>X</u>	72
A+D	10. form gate electrode	x	x	x	x		x				x						x		
A	11. form "1 <sup>st</sup> conductive pattern"							x	x					x	x	x		x	x

MATRIX OF LIMITATIONS vs. CLAIMS continued 2 of 5

CLAIM LIMITATIONS

Independent Claim Number

form 1 <sup>st</sup> insulating layer on exposed portions of:	1	5	6	10	12	15	17	20	23	27	30	31	32	34	36	39	41	66*
12. the oxide layer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13. the junction layer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14. the gate electrode (or "conductive pattern")	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15. form 1 <sup>st</sup> plurality of contact holes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16. form 1 <sup>st</sup> contact hole to expose junction layer and/or 1 <sup>st</sup> conductive pattern	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1 <sup>st</sup> plurality of contact holes or "the hole" exposes:	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17. junction layer(s) (or "1 <sup>st</sup> and/or 2 <sup>nd</sup> regions")	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
18. gate electrode(s) or conductive pattern	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19. 1 <sup>st</sup> contact holes of substantially equal depth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
20. 1 <sup>st</sup> contact holes have tapered upper portion	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21. fill 1 <sup>st</sup> contact holes with 1 <sup>st</sup> material layer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
22. form (1 <sup>st</sup> or 2 <sup>nd</sup> ) "conductive material" layer into the holes, "entirely"	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23. first layer is "metal" and is filled into the holes, "entirely"	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

A

A

A

A+D

A

A+C+E+D  
entirely

A

A

MATRIX OF LIMITATIONS vs. CLAIMS continued 3 of 5

Independent Claim Number

CLAIM LIMITATIONS

	1	5	6	10	12	15	17	20	23	27	30	31	32	34	36	39	41	66*
24. fill 1 <sup>st</sup> layer "by one single step"		x																
25. fill 1 <sup>st</sup> layer in holes "in a continuous step"				x														
26. 1 <sup>st</sup> layer is grown over and "extends slightly beyond" first plurality of contact holes	x	x	x	x														
27. form a conductive pattern on 1 <sup>st</sup> insulating layer spaced from 1 <sup>st</sup> metal layer (and/or spaced from 1 <sup>st</sup> conductive material layer)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
28. form a "second conductive pattern"														x			x	x
form 2 <sup>nd</sup> insulating layer on exposed portions of the:																		
29. the conductive layer pattern on 1 <sup>st</sup> insulating layer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
30. the first insulating layer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
31. the 1 <sup>st</sup> plurality of holes or single hole	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
32. form 2 <sup>nd</sup> plurality of holes in second insulating layer or single hole	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
33. 2 <sup>nd</sup> plurality of holes are of substantially equal depth	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

*Argument*

A+C+

A\*

K+C

A

A

A

**Independent Claim Number**

1 5 6 10 12 15 17 20 23 27 30 31 32 34 36 39 41 66\*

[illegible]

## Independent Claim Number

**Independent Claim Number**

(X)

teaching